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MICROPHONE SYSTEM FOR IN-CAR AUDIO PICKUP

CROSS-REFERENCE TO RELATED APPLICATIONS:

This application claims priority from provisional application Serial No. 60/214,873 filed June 28, 2000.

FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT:

Not Applicable.

BACKGROUND OF THE INVENTION:

Technical Field

The present invention relates to a system for discerning an audible command from ambient noise in a vehicular cabin, and more particularly, to such a system which permits audible control of vehicular functions.

Microphones located in vehicular cabins for detecting the voice of a speaker, such as of the driver and/or passengers, are well known. Typically, such microphones are for person-to-person telecommunication devices, such as cellular telephones or two-way radios.

Vehicular cabins tend to be a relatively noisy environment, including such ambient noise sources as wind noise, road noise, radio noise, fan noise, or the like. Such an

environment can make accurate voice detection and recognition difficult.

The location of the speaker in a vehicular cabin also can vary, as people tend to be of different sizes, they tend to shift in their seating, and the location of a seat in a vehicle can change.

In person-to-person communication, the quality of the voice signal is not as critical, because the human ear and sound processing ability can help distinguish the voice from the noise. However, in human-to-machine communication, such as for voice control of vehicular functions, such voice degradation can prevent the system from operating.

The present invention is provided to solve these and other problems.

SUMMARY OF THE INVENTION:

It is an object of the invention to provide a system for discerning an audible command from ambient noise in a vehicular cabin.

In accordance with the invention, the system comprises a microphone array and a signal processing system.

It is contemplated that the microphone array is one-, two-, or three-dimensional.

It is further contemplated that the microphone array may be pivotally mounted in the vehicular cabin, such as within the vehicle's mirror. Alternatively, the microphone array may be located within the vehicle's headliner, overhead console, dashboard, visor, pillar, headrest, steering wheel, compartment door, or such other interior surface of the vehicle.

It is still further contemplated that the signal processing system may be analog, wherein the analog signal processing system performs a delay and sum processing function. Alternatively, the signal processing system may be digital, wherein the digital signal processing system performs Griffiths Jim processing, Frost processing, or adaptive signal processing, such as adaptive beamforming and/or adaptive noise reduction.

It is yet further contemplated that the system includes a plurality of microphone arrays, and the signal processing system includes multiple output channels.

It is still yet contemplated that the vehicle has a controllable parameter, and the system includes means responsive to the audible command for controlling the parameter.

It is further contemplated that the system includes means for detecting failure of one

microphone of the microphone array, and means responsive to the failure detection for compensating for the failure of the microphone.

BRIEF DESCRIPTION OF THE DRAWINGS:

FIG. 1 is a block diagram of a system for discerning an audible command from ambient noise in a vehicular cabin, in accordance with the invention;

FIG. 2 is a block diagram of a second embodiment of a system for discerning an audible command from ambient noise in a vehicular cabin, in accordance with the invention; and

FIG. 3 is a perspective drawing of a vehicular cabin, illustrating locations for microphone arrays, in accordance with the invention;

DETAILED DESCRIPTION OF THE INVENTION:

While this invention is susceptible of embodiment in many different forms, there is shown in the drawings and will herein be described in detail preferred embodiments of the invention with the understanding that the present disclosure is to be considered as an exemplification of the principles of the invention and is not intended to limit the broad aspect of the invention to the embodiments illustrated.

A first embodiment of a system **10** for discerning an audible command from ambient noise in a vehicular cabin, is illustrated in FIG. 1. The system includes a microphone array **12.** The microphone array **12** preferably includes four microphones **14**, although other quantities are possible. The microphone array **12** can be one-, two- or three-dimensional. Each of the microphones is coupled to a band-pass filter **16**, which are each coupled to a respective amplifier **18**. Each of the amplifiers is coupled to delay and weighting circuitry **20**, which outputs are coupled to an analog or digital signal processor **22**. The signal processor performs adaptive beam forming so that the microphone's pick-up pattern can be best directed at the speaker. The signal processor has one or more analog or digital outputs **24**, which are coupled to such devices as a cell phone, or circuitry to control vehicular functions, such as controlling the radio, the heater/air conditioner, or the like. A more detailed explanation can be found in PCT Application WO 00/30264.

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A second embodiment of a system **10'** for discerning an audible command from ambient noise in a vehicular cabin, is illustrated in FIG. 1. Like components have been given the same reference numbers as in the embodiment of FIG. 1. In the system **10'**, each of the microphones **14** of the microphone array **12** is coupled to a respective one of the amplifiers **18**, which is each coupled to a respective one of the delay and weighting circuitry **20**. The outputs of the delay and weighting circuitry **20** are summed by a summer **26**. The output of the summer **26** is coupled to the bandpass filter **16**, which is coupled to an analog or digital signal processor **22.** As with the first embodiment, the signal processor **22** has one or more analog or digital outputs **24**, which are coupled to such devices as a cell phone, or circuitry to control vehicular functions, such as controlling the radio, the heater/air conditioner, or the like.

Referring to FIG. 3, the microphone array **12** can be pivotally mounted in the vehicular cabin, to better aim the pick-up pattern at the speaker. Preferably, the vehicular cabin includes a rearview mirror **30**, and the microphone array **12** is located within the mirror **30.** By placing the microphone array **12** in the mirror **30**, the direction of the microphone array **12** will be adjusted relative to the position of the driver. A potentiometer, or other position sensor, can be attached to the mirror **30**, such that the position of the mirror **30** can be detected. This positional information can be used by the signal processor **22** for further adjustment of the beam of the microphone array **12.**

Other locations for the microphone array **12** are also possible. For example, the vehicular cabin includes a headliner **32**, and the microphone array **12** can be located within the headliner **32.** The vehicular cabin may also include a overhead console 34, and the microphone array **12** can be located within the overhead console **34.** The vehicular cabin includes a dashboard **36**, and the microphone array **12** can be located within the dashboard **36.** The vehicular cabin also includes a visor **40**, and the microphone array **12** can be located within the visor **40.** The vehicular cabin includes also a pillar **42**, and the microphone array **12** can be located within the pillar **12.** Other possible locations include a headrest **44**, a steering wheel **46**, or a compartment door **48.**

The signal processor **22** can perform various signal processing techniques, such as Griffiths Jim processing, Frost processing, or adaptive signal processing. It can also perform

adaptive noise reduction. The signal processing may also be acoustic. The signal processor **22** includes circuitry for detecting failure of one of the microphones **14** of the microphone array **12**, and circuitry responsive to the failure detection for compensating for the failure of the microphone **14.** The signal processor **22** is selectively directional between two potential audible command sources.

While the specific embodiments have been illustrated and described, numerous modifications come to mind without significantly departing from the spirit of the invention and the scope of protection is only limited by the scope of the accompanying Claims.